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INSECT DAMAGE IN HARDWOOD SAWLOGS

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Frontispiece.--Logs and lumber were examined at 19 small sawmills.

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Kentucky's forests average about 20 sawtimber-size trees per acre. About 4 of these are culls--trees that are unmerchantable for sawlogs now or prospectively because of defect, rot, or unwanted species[1/].

Insects are responsible, directly or indirectly, for much of the poor-quality and cull sawtimber. Recently the Forest Experiment Station made a survey to find out just how extensive and serious insect damage to Kentucky's hardwood forests is. Investigation was confined to the damage caused by insects actually entering the wood of living trees.

Nineteen small sawmills were visited in the 12 southeastern counties where the State's lumber production is concentrated (fig. 1). Logs on the decks were examined for indications of internal insect damage. Then the lumber cut from these logs was examined immediately after sawing to verify the external evidence of damage and to get an estimate of the amount of damage (frontispiece). The results of this study are reported here.

1/ Hutchison, O. Keith, and Winters, Robert K. Kentucky's forest resources and industries. U. S. Dept. Agr. Forest Resources Rpt. No. 7, 56 pp., illus. 1953.

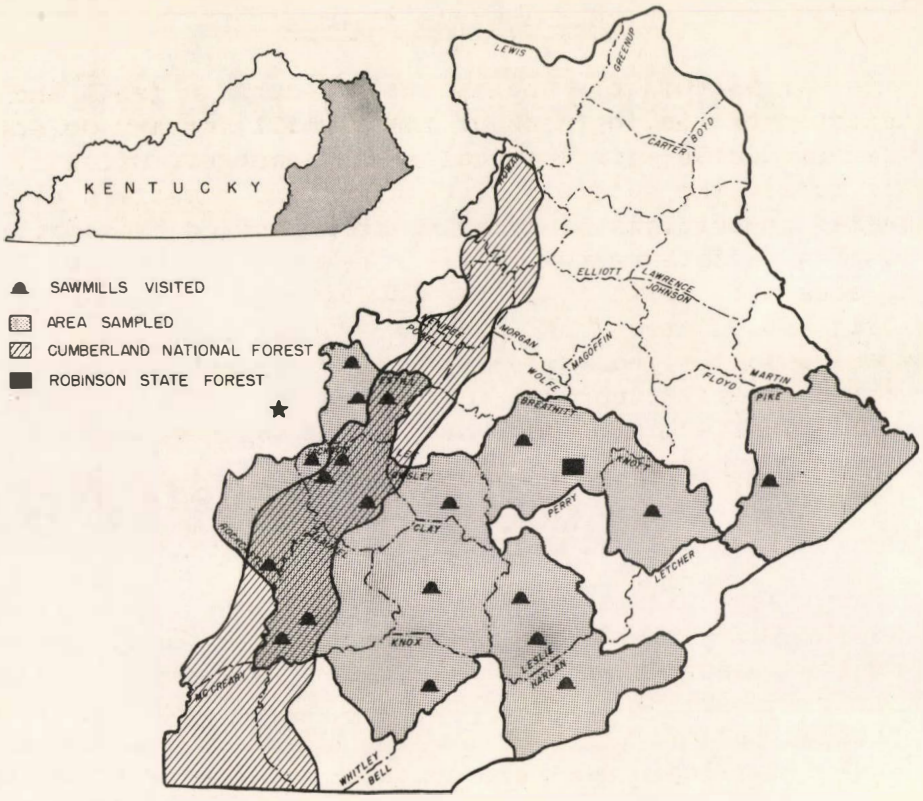

Figure 1.--Location of sawmills visited in southeastern Kentucky.

Selection of Logs Sampled

The predominant hardwood species in the Eastern Highlands of Kentucky are black oak, scarlet oak, chestnut oak, hickory, yellow-poplar, white oak, beech, and northern red oak. Approximately 45 percent of the lumber produced in this section is oak. So emphasis was placed on the oaks when making this survey. Other hardwood species were tallied when they were mixed in with oaks on the log decks.

We planned to sample 10 or more logs per sawmill. However, this was not always possible. As a result, in each of two counties less than 10 logs were tallied.

Only freshly cut, green sawlogs were included. Logs that are allowed to lie too long after being cut, or trees already dead when cut, are damaged by insects that cause injury similar to that caused by insects attacking living trees.

Examination of Logs

As far as possible the entire log surface (ends and sides) was inspected on the log deck of the sawmill for any defects that might be associated with internal insect damage. Often it was impossible to see the entire surface of a log; sometimes patches of mud covered up portions of a log. More detailed examination of the logs would have interrupted milling operations. Defects listed for the log ends are: rot, insect holes, "grease" spots, and large holes (fig. 2). Defects listed for the bark surfaces are: knots (sound and unsound), holes, wounds, fire injury, and bumps. Other information recorded included log length, diameter of the small end of each log inside bark, and position the log occupied in the tree stem--butt or upper portion.

Examination of Lumber

The insect damage on each board cut from a sample log was noted as the boards moved along the conveyor rollers. An exact count of the insect holes (borer and shot) was made up to 20; beyond that number a close estimate was made. Each board was visually divided into four quarters, with the first quarter at the lower end of the log. Quarters containing holes were checked on the tally sheet. This permitted the damaged volume in each log to be roughly estimated.

Figure 2.--Borer damage in oak logs.

Borer or grub holes may be defined as oval, circular, or irregular in shape and 3/8 to 1 inch in diameter; shot or pin holes are round holes less than 1/4 inch in diameter (fig. 3).

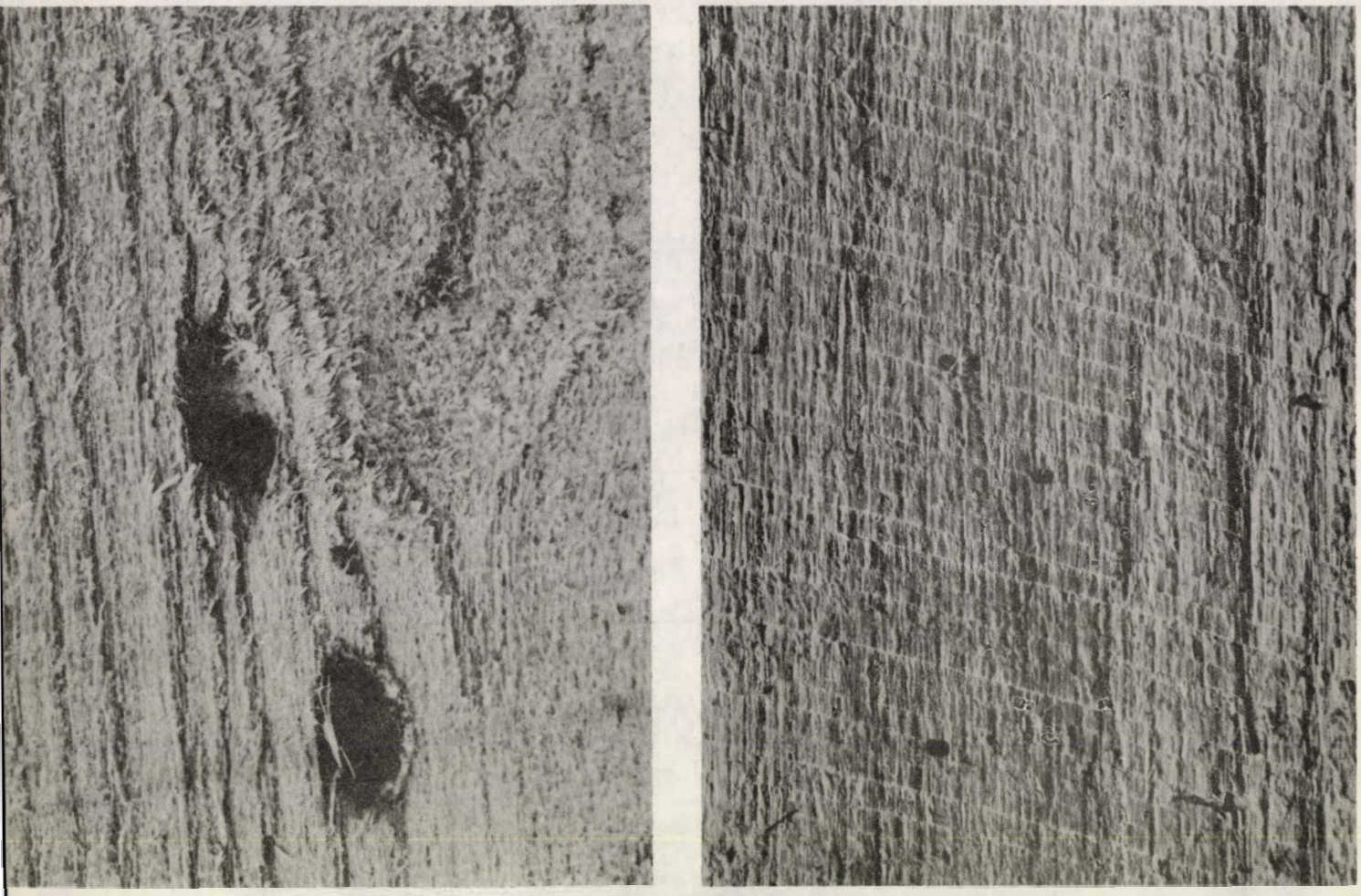

Figure 3.--Full-size photos of borer holes (left) and shot holes (right).

RESULTS AND DISCUSSION

Amount of Insect Damage to Logs

Altogether, 219 logs were sampled; 82 percent of them were oaks. The diameter inside bark of the logs at the upper end ranged from 8 to 36 inches and averaged 14 inches; log lengths varied from 8 to 20 feet, averaging 12 feet.

Internal insect damage was present in 88 percent of the oak logs and in only 53 percent of the logs of other hardwood species. Chestnut oak had the least insect-damaged logs in the oak group with a percentage of 73, and black oak the highest with 98 percent. Examination of all the boards bears out the evidence in the logs that there is more insect damage in oaks than any other hardwood species. Insect holes were present in 73 percent of the oak boards, but only in 13 percent of the boards of other hardwoods. General observations of lumber piles and logs indicate that the severity of damage is about the same throughout the region.

Table 1 shows the percent of board-foot volume damaged per log and the mean number of borer and/or shot holes per log for the various species of oaks. Unfortunately only 8 white oak logs were sampled.

In the tables, "other hardwoods" include yellow-poplar, hickory, basswood, beech, sugar maple, blackgum, cucumbertree, and ash. The percentages given for the volume damaged are maximum figures since they represent entire board quarters. Many permissible cuttings from damaged boards would be possible, thereby increasing the usable volume per log.

All of the figures in table 1 are based on 1-inch boards. Eighty-two percent of the lumber was sawed into 1-inch boards, 15 percent went into 2-inch boards, and the remaining 3 percent went into boards 3, 4, or 8 inches thick. When a board was greater than 1 inch thick, the number of insect holes and damaged board quarters was multiplied by the thickness in inches. A total of 2,421 boards were examined. The actual number of lineal feet of lumber examined per log ranged from 42 to 432 feet, and averaged 171 feet.

Table 1.--Volume damaged and mean number of borer and/or shot holes per log (based on 1-inch boards) by species

Species	Number of logs	Borer holes: Mean No.	Borer holes: Volume damaged	Shot holes: Mean No.	Shot holes: Volume damaged	Borer and shot holes: Mean No.	Borer and shot holes: Volume damaged
			Percent		Percent		Percent
Black oak	66	31	33.5	47	10.5	78	37.6
Chestnut oak	49	4	2.2	88	44.1	92	45.8
Red oak	28	30	22.3	88	9.1	118	27.8
Scarlet oak	28	49	38.7	26	7.6	75	40.5
White oak	8	8	10.5	1/	.3	8	10.8
All oaks	179	25	20.7	59	21.2	84	38.3
Other hardwoods	40	1	1.2	41	7.3	42	8.6
All hardwoods	219	21	16.7	56	18.3	77	32.2

1/ Less than 1.

All of the oaks, except white oak, showed significant damage from insects. Chestnut oak had the most with 45.8 percent of the volume damaged. Almost all of this was attributable to the shot-hole group of insects. The scarlet, black, and red oaks in that order were damaged primarily by the borer group of insects. The distribution of the shot holes in the chestnut oaks and red oaks accounts for the great difference in percent of volume damaged--41.1 percent for chestnut oak and 9.1 percent for red oak--even though they both have the same average number of holes, 88. When a chestnut oak log is infested by beetles making shot holes, the holes are usually well distributed over the entire surface of most of the boards cut from that log. However, in an infested red oak log the shot holes are apt to be bunched in one, two, or three of the board quarters. This is also true for the black and scarlet oaks.

The 8.6 percent of volume damaged shown for other hardwoods in table 1 indicates the low incidence of insects in these species. This is especially true for yellow-poplar, beech, and blackgum. The 7.3 percent damage from shot-hole injury in basswood, hickory, and sugar maple makes up most of this 8.6 percent. Of these three species, basswood had 22 percent of the volume damaged, hickory had 14.6 percent, and sugar maple 11.2 percent.

Insect Population in Logs and Trees

We cannot tell of course exactly how many insects attacked each log. However, if we are familiar with the boring habits of the various wood-damaging insects, and if we know how many holes were found in lumber cut from logs of various species, we can deduce the degree of infestation that each species has suffered (fig. 4).

For example, members of the borer group that attack living trees construct larval tunnels that more or less wander at random through the sapwood and heartwood (fig. 5). Most of the shot-hole beetles known to attack living trees bore adult galleries that fork into a number of branch tunnels. One species making shot holes excavates irregular cavities and longitudinal burrows in the wood.

Figure 4.--Borer in oak lumber (full size).

Figure 5.--Larval tunnels of some borers apparently wander aimlessly through the wood.

The estimated number of insects per log for the various host tree species is given in table 2. These averages are based on the number of insect holes in the board containing the greatest number of holes for that log. Borer holes and shot holes are listed separately.

Frequency distribution tables were set up on all shot-hole-infested boards (28 percent of all boards examined) and on all borer-infested boards (33 percent of all boards examined) in order to determine the degree of infestation per board. Results for shot holes show that 1 to 4 holes constitute a lightly infested board; 5 to 10 holes, moderate; and 11 or more holes, heavy. For borer holes 1 hole would be light; 2 to 4 holes, moderate; and 5 or more, heavy.

By applying the foregoing information to the mean number of borer holes or shot holes (table 2), it is possible to determine the degree of infestation in each tree species sampled. Thus we find that scarlet, black, and red oaks were heavily infested with borers, white and chestnut oaks were moderately infested, and the remaining hardwoods were only lightly infested. Turning to shot-hole insects, we find that black and red oaks were again heavily infested, while scarlet and chestnut oak were moderately infested. Less than one hole was recorded for white oak, which places it in the lightly infested class along with yellow-poplar, beech, and blackgum. Hickory, basswood, and sugar maple show a heavy infestation. It might be well to point out again that any data pertaining to hardwood species other than the oaks and yellow-poplar should be considered with some reserve because so few logs of these other species were sampled.

Table 2.--Estimated number of insect injuries per log by tree species

Species	Borers		Shot-hole beetles		Total mean
	Maximum	Mean	Maximum	Mean	
Black oak	32	7	130	14	21
Chestnut oak	25	2	102	10	12
Red oak	20	6	100	12	18
Scarlet oak	25	9	50	5	14
White oak	13	4	1	1/	4
Yellow-poplar	6	1/	--	--	1
Hickory	--	--	100	17	17
Basswood	--	--	200	51	51
Beech	2	1	--	--	1
Sugar maple	3	1/	50	14	14
Blackgum	2	2	1	1/	2

1/ Less than 1.

Effect of Tree Size on Amount of Insect Damage and Number of Insects

Diameter at breast height of the trees from which the 78 logs were cut was derived from butt-log dimensions by means of a form-class table. D.b.h. ranged from 10 to 48 inches. The diameter at breast height was grouped into three equal classes to determine the trend in damage and amount of infestation. Comparing tree diameter with insect damage indicates that the amount of insects and damage present can be expected to increase with tree size (table 3).

Table 3.--Percent of volume damaged and mean number of insects per butt log, by d.b.h. class for all of the oaks

D.b.h. class (inches)	Number of logs	Percent of volume damaged	Mean number of insects
10 - 22	52	31	12
23 - 35	22	44	15
36 - 48	4	48	69

Insect Damage in Butt and Upper Logs

The amount of injury and the average number of insects per log were found to be nearly the same. However, 85 percent of the butt logs showed internal insect damage, as compared with 79 percent for upper logs.

Effect of External Surface Defects on Amount of Internal Insect Damage in Logs

Slightly more than half of all the hardwood logs examined showed external surface defects that might be associated with internal insect injury. It is most probable that the number would have been greater had a more thorough examination of the logs been possible. Therefore, we should accept reservedly the percentage of logs having no external surface defects but found to contain internal insect damage.

Stain Associated with Insect Holes

Snyder[2/] has stated that stain may or may not be associated with holes made by borers or shot-hole beetles in living trees, depending on the insect species (fig. 6). In this study, 98 percent of the borer-type holes were stained (table 4). Holes making up the remaining 2 percent were found in black, chestnut, and white oaks. More than 90 percent of the holes of the shot type were found to be unstained in all of the oak species except chestnut oak, where 90 percent of the holes were stained.

2/ Snyder, Thomas E. Defects in timber caused by insects. U. S. Dept. Agr. Bul. 1490, 47 pp. 1927.

Table 4.--Number of stained versus non-stained holes

Species	Borer holes[1]		Shot holes	
	Total	Stained	Total	Stained
	Number	Percent	Number	Percent
Black oak	2,051	98	3,038	1
Chestnut oak	134	78	4,291	90
Red oak	826	100	2,468	6
Scarlet oak	1,356	100	734	[2]
White oak	62	95	1	0
Yellow-poplar	26	100	--	--
Hickory	--	--	360	100
Basswood	--	--	937	100
Beech	10	100	--	--
Sugar maple	3	100	341	51
Blackgum	2	100	1	0
Cucumbertree	--	--	4	100
Ash	1	100	--	--

1/ Does not include 85 holes that were in rotted or wounded tissue.

2/ Less than 0.5 percent.

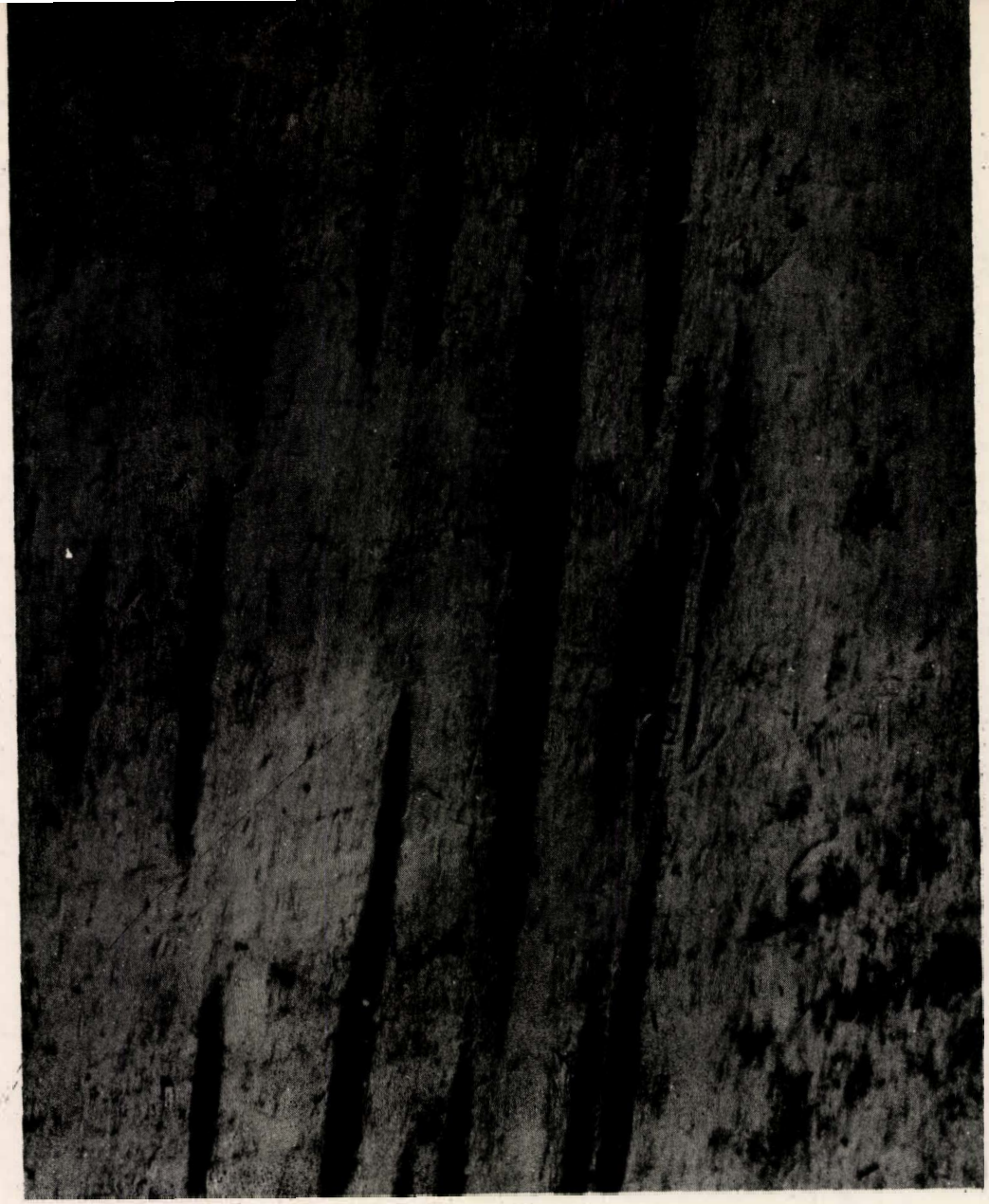

Figure 6.--Shot-hole-borer damage associated with stain in basswood.

FUTURE RESEARCH

This survey has demonstrated one approach to an actual measurement of the insect damage to timber that has been only vaguely acknowledged until now. A second accomplishment lies in the revealed possibilities for greater economies in logging through an intensive research program. The Central States Forest Experiment Station and the Kentucky Agricultural Experiment Station have agreed to cooperate in conducting research to determine the insect species involved, their life history, habits, and ecology; to determine the relation between conditions of growth, site, stand density, and forest type to insect defects in sawtimber.

SUMMARY

A survey in eastern Kentucky was undertaken to study the seriousness of insects entering and damaging the sapwood and heartwood of living hardwood sawtimber. Insects are known to be responsible in a large measure for the poor-quality and cull hardwood logs and lumber commonly found throughout the Central States and Appalachian Regions.

Logs were sampled at 19 sawmills in 12 counties located in the southeastern part of Kentucky where lumber and timber production rank high in the State. The log surface and ends were examined for defects before cutting and then the resulting lumber inspected for insect damage.

About 82 percent of the 219 logs sampled were oak. Internal insect damage was present in 88 percent of the oak logs, while 73 percent of the oak boards showed insect injury.

All of the oaks but white oak showed a moderate to heavy infestation. The black and red oak species were the most heavily infested, with scarlet oak closely approaching their high degree of infestation. Chestnut oak had the greatest amount of volume damaged (45.8 percent), but was only moderately infested by both borers and shot-hole insects.

Tree size apparently has an influence on the degree of infestation and damage by insects. The amount of insects and damage can be expected to increase as the tree grows.

Butt logs show a slightly greater percentage of internal insect damage than logs from the upper portion of the main stem. However, the percent of injury and average number of insects per log were nearly the same as for upper logs.

An intensive research program is now getting underway to study the cause and control of insect damage to hardwood sawtimber in eastern Kentucky.

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